THURSDAY, MAY 2, 1918.

OUR HERITAGE OF SCIENCE.

(1) *Britain's Heritage of Science.* By A. Schuster and A. E. Shipley. Pp. xv+334. (London: Constable and Co., Ltd., 1918.) Price 8*s*. 6*d*. net.

(2) *A Short History of Science.* By Prof. W. T. Sedgwick and Prof. H. W. Tyler. Pp. xiv+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1917.) Price 12*s*. 6*d*. net.

(1) THE main purpose of the first of these two historical books is to give a plain account of Britain's great heritage of science: "an heritage that—handed down through several centuries of distinguished achievements—will, if the signs speak true, be passed on to the coming age with untarnished brilliancy." It is a legacy to be proud of and to use. Prof. Schuster starts off with a fine chapter on the ten landmarks of physical science associated with the names of Roger Bacon, Gilbert, Napier, Newton, Dalton, Young, Faraday, Joule, William Thomson, and Clerk Maxwell. Then follows a sketch of physical science in the universities during the seventeenth and eighteenth centuries, and the achievements of men like Halley and Hooke, Bradley and Black. The non-academic succession is illustrated by the work of Boyle, Cavendish, Priestley, Herschel, and Watt. Through Rumford and Davy and George Green the author passes to the golden age of mathematics and physics at Cambridge associated with the names of Stokes and Adams, Sylvester and Cayley. His survey broadens out to include the work of Thomson and Tait, Rankine and Fitzgerald, and other illustrious physicists of the nineteenth century. Thus the author deals with such investigators as Graham, Joule, Balfour Stewart, Reynolds, Sorby, Crookes, Rayleigh, George Darwin, Ramsay, Rutherford, Airy, John Herschel, Adams, and Gill, and the distinguished roll fitly ends with Henry Moseley, whose career of singular promise was cut short in 1915 by a Turkish bullet. The next chapters illustrate the function of scientific institutions, such as the Royal Society, and "the effects of pure scientific research on that complex organisation of the community which usually goes by the name of civilisation."

Prof. Schuster's historical sketch is illuminating and inspiring—a fine example of wise selection of materials. In illustration of his judicial spirit we may refer to what is said about the estimation of the relative merits of co-operative discoverers. A generalisation gradually matures; many investigators may contribute to it; "when the time is ripe, some one with a better appreciation of the significance of the facts or a deeper insight into their mutual connection touches the matter with a master hand, and presents it in a form that carries conviction." Sometimes there is a long balancing of arguments for and against a new idea; he who adds the last grain that tips the balance is technically the discoverer. "There will always be a conflict between those who attach importance to the intrinsic merit of an investigation and those who look only on the actual influence it has had on scientific thought."

Dr. Shipley begins with the biological science of the Middle Ages; he sketches the development of botany in Britain from Turner to Ray, from Grew to Hales, from Knight to Brown, from Lindley to Hooker; he outlines the history of British zoology from Pennant and the Hunters to Owen and Huxley, from Erasmus Darwin to Charles Darwin, from Robert Chambers to Alfred Russel Wallace, and on to Balfour and Weldon, and to a master of the craft still with us, Sir E. Ray Lankester. A vivid sketch is given of the progress of physiology from Harvey and Hales to Michael Foster and Burdon Sanderson, and on to Wooldridge and Roy. The growth of geology sketched in the final chapter affords a crowning instance of the glory of the British heritage of science.

Dr. Shipley's story leaves one a little breathless, but this is because of the magnitude of his subject and the compulsory compression. His style is as vivid and delightful as ever; but we cannot approve of a construction like "the latter of whose work . . ." Some omissions strike us as curious; thus mention is made of four marine laboratories, but that at Millport, with the second largest record of researches, is left out; we find no mention of John Goodsir, whose work had far-reaching importance; and we are a little startled by finding no reference to the author of "The Principles of Biology." But we must not pursue the quest for omissions. Dr. Shipley makes some wise remarks on the limitations of science: "No body of scientific doctrine succeeds in describing in terms of laws of succession more than some limited set of stages of a natural process; the whole process—if, indeed, it can be regarded as a whole—must for ever be beyond the reach of scientific grasp. The earliest stage to which science has succeeded in tracing back any part of a sequence of phenomena itself constitutes a new problem for science, and that without end. There is always an earlier stage, and to an earliest we can never attain. The questions of origins concern the theologian, the metaphysician, perhaps the poet."

The authors have no thesis to establish, but their valuable book will leave in the minds of those who read it a strong impression of the large number of contributions of the first rank in importance that Britain has made to science, which is by its very nature cosmopolitan; and of the extent to which, in spite of our calamitous neglect, we are nationally indebted to science for advancement in mind, body, and estate. But we have not had more than the first-fruits.

(2) The aim of the second book is "to furnish a broad, general perspective of the evolution of science, to broaden and deepen the range of the students' interests, and to encourage the practice of discriminating scientific

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reading." The authors believe that students will understand modern science better if they know more of its development, and we share this belief. Prof. Sedgwick is mainly responsible for the treatment of the "natural sciences"; Prof. Tyler for the mathematical. "The mathematical group, from their relatively greater age and higher development, afford the best examples of maturity; the natural sciences illustrate more clearly recent progress."

A considerable proportion of the volume—perhaps too much—is devoted to early history. In a very interesting way we are told of the gropings of the incipient scientific spirit in early civilisations, of early mathematics in Babylonia and Egypt, of beginnings in Greece and among the Ionian philosophers, of science in the Golden Age of Greece, of Alexandrian science, of science in the Roman world, and of Hindu and Arabian science. We are gradually led to the beginnings of modern natural science, which may be typified by the fundamental work of Galileo. The progress of the seventeenth century is illustrated by the work of men like Harvey, Boyle, Hales, and Huygens; the beginnings of modern mathematical science are found in Descartes, Newton, and Leibniz. The next chapter deals with the eighteenth century, and we read of Black, Cavendish, Priestley, Lavoisier, Scheele, and others in chemistry; the pioneers in the study of heat, light, sound, and electricity; the classifications of Linnæus, the descriptions of Buffon, the comparative anatomy of Hunter, the physiology of Haller, and so on. The story of the nineteenth century, all too short, is mainly concerned with the conception of energy, the rise of modern chemistry, and the development of genetic inquiries along many lines—geological, astronomical, biological, and anthropological.

There are some very interesting appendices, *e.g.* the oath of Hippocrates, the sixth part of the "Opus Majus" of Roger Bacon, the dedication Copernicus wrote to his "Revolutions of the Heavenly Bodies," Harvey's dedication of his work on the circulation, Galileo Galilei's condemnation and recantation, Newton's preface to the "Principia," and excerpts from Jenner and Lyell. There is a brief discussion of the origin of some inventions of the last two centuries. In a useful chronological list great names and dates in science are placed opposite great names and dates in general history and literature. And the volume ends with a selected list of reference books bearing on the history of science.

We appreciate the authors' scholarly and careful work, which will be of great value to serious students. The task attempted was perhaps too ambitious; for twenty authors, rather than two, would be required to show the true inwardness of the progress of scientific inquiry in its various departments. Sometimes the reader does not get enough material to enable him to understand the drift of the history; sometimes he will be apt to lose the wood in the trees. The success of the authors is most marked in the chapters dealing with early days, and in those sections where they have concentrated attention on the development of particular conceptions, such as energy or organic evolution. We like the frequent citation of typical passages from authorities, and we admire the solid competence of the whole work. There are some interesting illustrations, *e.g.* of Tycho Brahe's quadrant, Huygens's clock, and Newton's theory of the rainbow.

REFRIGERATION AND RELATED SUBJECTS.

La Statique des Fluides, la Liquéfaction des Gaz, et l'Industrie du Froid. By E.-H. Amagat and L. Décombe. Première Partie: *Statique des Fluides Purs.* By E.-H. Amagat and L. Décombe. Deuxième Partie: *La Problème de la Liquéfaction des Gaz, l'Industrie du Froid.* By L. Décombe. Pp. vi+265. (Paris and Liège: C. Béranger, 1917.) Price 18 francs.

THE first part of this book deals with the properties of liquids and gases, giving a very clear summary of some of the more important experimental work carried out in this branch of physico-chemical research. Amagat's work and conclusions are recorded in considerable detail, as well as much of the work of other physicists. The researches carried out by the great French physicist are of such importance that readers will be glad to have this connected account of them.

The compressibility of gases at different temperatures receives full consideration, and is illustrated by reproductions of the dpv/dp isothermals for ethylene, methane, carbon dioxide, air, and hydrogen. The curves for the last-mentioned gas are taken from the work of Onnes and Braak (1907) from -180° C. to -217° C., demonstrating that hydrogen at sufficiently low temperatures exhibits a minimum value for pv on the isothermals, as do other gases at higher temperatures. Van der Waal's equation, constituting an important advance with regard to our knowledge of the compressibility of gases, is given a prominent position in the book. The equations of Clausius, Sarrau, Amagat, and Onnes are briefly dealt with.

The application of the reduced equation of state (corresponding states) by Amagat to the determination of critical constants, by ascertaining the conditions of coincidence of the dpv/dp isothermals of different substances, is described in detail, and illustrated by superposition of the curves for carbon dioxide and ethylene, and carbon dioxide and ether. Leduc's work on molecular volumes in corresponding conditions receives attention, as well as the application of the method to the accurate determination of molecular and atomic weights. An interesting comparison of the results obtained for the atomic weights of a number of elements determined in this way with those obtained from density determinations shows that a high degree of accuracy obtains in most cases.

The study of refrigeration, dealt with in the second part of the book, opens with a brief account of the history of the liquefaction of gases. A chapter is devoted to the consideration of the

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